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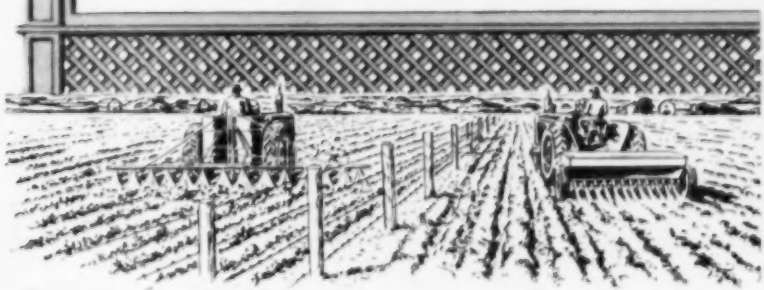

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NEWS AND REVIEWS

OUR COVER PICTURE—*Nothing is more beautiful and inspiring to a potato grower than a field of healthy potato plants in full bloom. The weather and mother nature work wonders with potatoes in Northern Maine. Photo Courtesy Maine Development Commission.*

EFFECT OF SEVERAL CHEMICALS ON SPROUTING OF STORED TABLE-STOCK POTATOES[1]

HERBERT FINDLEN[2]

During the latter part of the late-crop shipping season, sprouts often develop on table-stock potatoes in transit to such an extent that they detract from the general appearance of the potatoes at the terminal market and reduce their value. Because the tubers have completed their rest period, sprouting is influenced to a considerable extent by the higher temperatures that may be encountered in storage and transit at this season. A treatment which would prevent sprouting of potatoes after grading and packing would be of value to both shippers and consumers. It would extend the marketing season of the late crop for the shippers and provide consumers with potatoes that would not sprout excessively. Thus, it would reduce weight loss and shrivelling.

Guthrie (5) found that good sprout inhibition could be obtained with methyl ester of alpha naphthaleneacetic acid (MENA), because, being volatile at room temperature, it could be introduced into uncut tubers in vapor form. Following this discovery, many investigators gave attention to the problem of inhibiting sprouting in potatoes by chemical means. Results of many studies show that application in an inert dust carrier was apparently best. The dust was formulated in varying concentrations, but 2.2 per cent was most commonly used. It was applied at the rate of 0.9 to 1 gram of MENA per bushel of potatoes (equivalent to 33 to 37 mg./kg.).

The material was found to be more effective if applied before sprouting occurs. Very limited commercial use was made of this dust to retard sprouting of potatoes when it was undesirable or impractical to store the potatoes at temperatures low enough to retard sprouting.

A rather limited amount of work has been done on sprout inhibitors applied in water. Alban (1), in a study of consumer packaging to reduce weight loss and sprouting, reported that 3 per cent MENA combined with Brytene 489A wax was very effective. Bradley and Dean (2), on the other hand, obtained unsatisfactory control of sprout growth when applying MENA as a dip at rates of 1, 3, and 9 grams per bushel to Chippewa potatoes from which sprouts ½ to 1 inch long had been removed. Marth and Schultz (7), working with tubers of the Katahdin variety which had completed their rest period but were free from sprouts, observed very little sprout development during 2 months' storage at 60° F. after dip treatment with 500 p. p. m. of MENA in either water or wax emulsion. The water dip appeared to be slightly superior to the emulsion.

[1]Accepted for publication December 17, 1954.
Report of a study made under the Agricultural Marketing Act of 1946 (RMA Title II).

[2]Horticulturist, Quality Maintenance and Improvement Section, Biological Sciences Branch, Agricultural Marketing Service, United States Department of Agriculture, East Grand Forks, Minn.

The diethanolamine salt of maleic hydrazide (MH) as a potato sprout inhibitor was compared with MENA in controlled laboratory experiments by Marshall and Smith (6). They found that sprouting of Green Mountain tubers immersed in 2,500 p. p. m. of MENA was completely inhibited from May 3 to July 22 when they were stored at 50° F., while MH at the same concentration had no effect. When tooth picks previously soaked in a solution of one or the other of these chemicals were inserted in the potatoes, however, MH proved to be more effective than MENA. In a review of the literature on potato sprout inhibition, Emilsson (4) stated that unpublished results in Sweden indicated that terpineol and alpha chloronaphthalene were far more efficient sprout inhibitors than MENA.

The present study was undertaken to determine the relative merits of several chemicals in aqueous emulsions or solutions in inhibiting sprout growth of potatoes previously stored for extended periods in a commercial warehouse. Since the investigation described herein was completed, Edwards (3) presented data showing that terpineol and alpha chloronaphthalene at 75 mg./kg. were relatively ineffective in suppressing sprout growth when applied to Sebago potatoes when sprouting was first noticeable.

Materials and Methods

MENA as a sprout inhibitor was compared with alpha chloronaphthalene, alpha terpineol, and the diethanolamine salt of MH. Several different concentrations of each chemical were used in preparing aqeuous solutions or emulsions of the various compounds.

Alpha terpineol and alpha chloronaphthalene were dissolved in a small quantity of acetone, and the solution thus obtained was added slowly with agitation to a paraffin-base wax emulsion. An 89-per cent formulation of MENA dissolved in an emulsifier was added directly to the wax or water. A solution containing 30 per cent MH by weight as the water-soluble diethanolamine salt was used. The aqueous emulsions or solutions of the various materials were diluted with distilled water to the desired concentrations.

Experimental lots of potatoes weighing 1,600 grams, each containing 10 tubers of approximately the same size, were used. Except in one preliminary experiment, each treatment was replicated 3 times. The potatoes tested were of the Triumph, Pontiac, and Red Pontiac varieties. They had been stored several months in a commercial storage house, the temperature of which had been gradually lowered and then maintained at 36° to 40° F. The tubers were dipped in or brushed with the liquids containing the various materials, dried at room temperature, placed in double-walled paper bags, and stored in a room with temperatures ranging seasonally from 56° to 60° and averaging 59°. The average relative humidity of the room was 61 per cent.

After storage for approximately 1 month at 59° F., the potatoes were removed from storage and weighed; then the sprouts were removed and weighed.

Effect of Various Treatments

Treatment of Dormant Red Pontiac Tubers with Three Chemicals—The first experiment was designed to compare the effectiveness of alpha

terpineol, alpha chloronaphthalene, and MENA in inhibiting sprouting of dormant potato tubers when these materials were incorporated in a wax emulsion. The wax emulsions containing the various materials were applied with a paint brush at the rate of 800 mg./kg. to washed Red Pontiac potatoes on March 9, 1950.

It was found in an earlier experiment that the quantity of acetone used to dissolve the alpha terpineol and alpha chloronaphthalene had little or no effect on sprout growth. Therefore, a replicated wax-acetone check was not included in this experiment.

In table 1 are shown the concentrations of the chemicals used, together with the weight loss from sprout removal and other weight loss.

Very little sprout growth occurred in the lots treated with MENA in wax even at the lowest concentration (17 mg./kg. of tubers). Other weight loss also was significantly lower than that of the checks, probably because MENA reduced respiration and transpiration. These potatoes appeared somewhat firmer than those treated with wax only or the untreated check at the termination of the experiment (Figures 1 and 2).

Although causing some sprout inhibition, alpha terpineol was less effective than MENA. Alpha terpineol at 50 mg./kg. of potatoes had practically no effect on sprouting, whereas 100 and 200 mg./kg. reduced sprouting somewhat but not as much as did the lowest concentration of MENA.

Alpha chloronaphthalene retarded sprout growth more than alpha terpineol did, but it was not so effective as MENA at similar concentrations. Thus, after 1 month's storage at 59° F., weight loss from sprout removal from tubers treated with MENA at 17 mg./kg. averaged only 0.03 per cent of the original tuber weight. However, tubers treated with alpha chloronaphthalene at the higher rate of 50 mg./kg. lost 0.51 per cent.

TABLE 1.—*Weight losses due to sprout removal and other weight losses of dormant Red Pontiac potatoes treated with three chemicals in wax March 9 and stored at an average temperature of 59°F. until April 7, 1950.*

Chemical	Application Rate (Mg./kg. of Potatoes)	Weight Loss (Per cent Original Tuber Weight)		
		Sprouts	Other	Total
MENA	17	0.03	3.54	3.57
MENA	33	0.03	3.45	3.48
MENA	67	0.02	3.10	3.12
Alpha terpineol	50	1.32	4.79	6.11
Alpha terpineol	100	0.43	4.02	4.45
Alpha terpineol	200	0.54	3.96	4.50
Alpha chloronaphthalene	50	0.51	4.06	4.57
Alpha chloronaphthalene	100	0.01	3.39	3.40
Alpha chloronaphthalene	200	0.00	4.47	4.47
Wax only	.....	1.39	4.55	5.94
None (untreated check)	.....	1.58	4.96	6.54
L. S .D. at .05 level	.....	0.49	0.93	1.13
L. S. D. at .01 level	.....	0.67	1.27	1.54

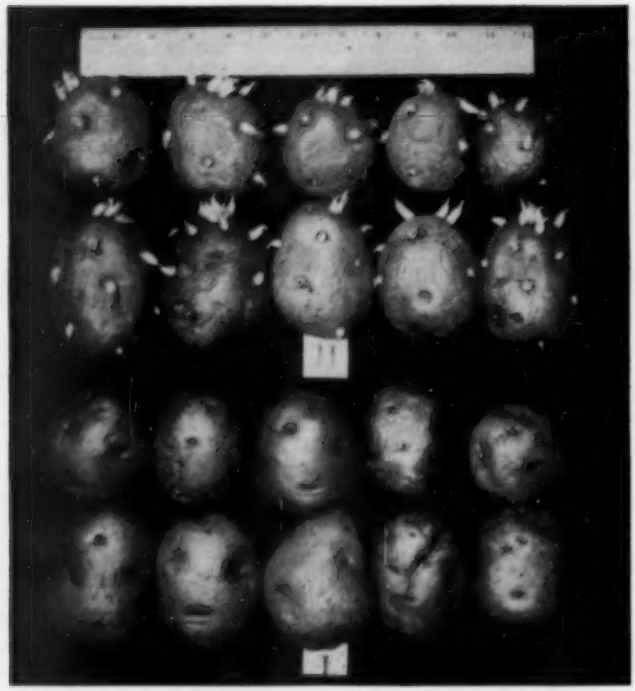

FIGURE 1.—Red Pontiac tubers treated with MENA incorporated in aqueous wax emulsion on March 9 and stored at an average temperature of 59° F. until April 7, 1950. I, MENA at 17 mg./kg. of potatoes; II, wax only.

Alpha chloronaphthalene at 100 mg./kg. inhibited sprout growth almost completely with only an occasional tuber possessing very short sprouts. The inactive buds of these tubers appeared necrotic as did a few lenticels on certain of the tubers.

Application of 200 mg./kg. resulted in complete death of the buds and caused necrotic spots at the lenticels of all tubers (Figure 2). This finding suggests that treatment of potatoes in cull piles with alpha chloronaphthalene would prevent sprouting and eliminate an early-season source of late blight fungus spores. No significant difference was found either in weight loss from sprout removal or in other weight loss between potatoes treated with wax alone and those untreated.

Treatment of Dormant and Non-Dormant Tubers with MENA at Low Concentration.—The results of the test just described suggested that even lower concentrations of MENA might adequately inhibit sprouting. An experiment was therefore conducted with dormant and non-dormant tubers of two varieties. A paraffin-base wax (B) to which known amounts of MENA had been added was compared with a commercial wax (A) containing an undisclosed amount of MENA.

Two lots of uniform-sized dormant tubers of the Triumph and

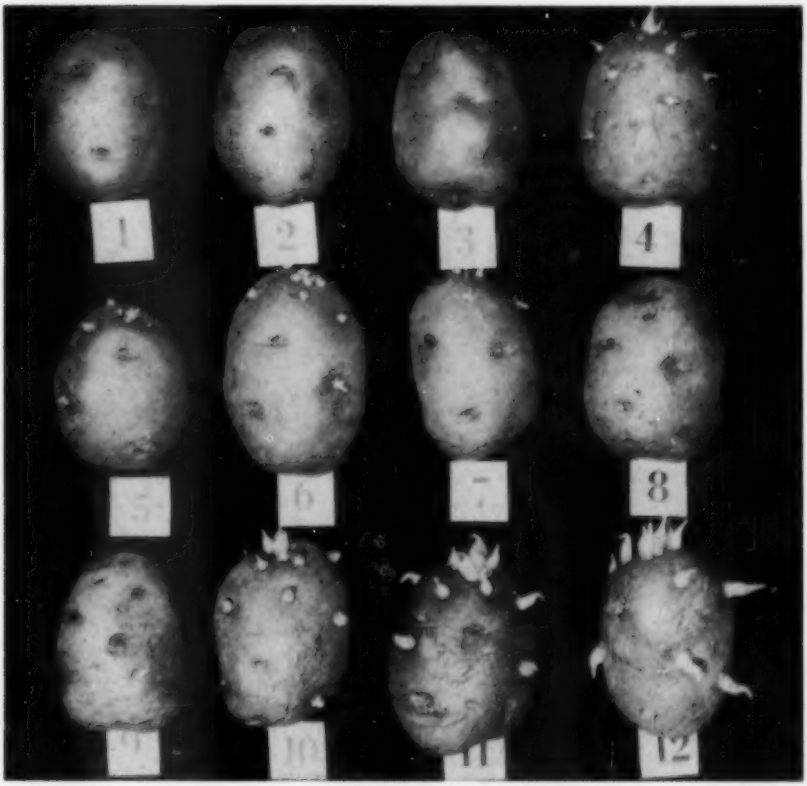

FIGURE 2.—Typical tubers of the Red Pontiac variety showing amount of sprout inhibition attained when they were treated with several different chemicals in wax and stored at an average temperature of 59° F. from March 9 to April 7, 1950. 1, MENA at 17 mg./kg. of tubers; 2, MENA at 33 mg./kg.; 3, MENA at 67 mg./kg.; 4, alpha terpineol at 50 mg./kg.; 5, alpha terpineol at 100 mg./kg.; 6, alpha terpineol at 200 mg./kg.; 7, alpha chloronaphthalene at 50 mg./kg.; 8, alpha chloronaphthalene at 100 mg./kg.; 9, alpha chloronaphthalene at 200 mg./kg.; 10, wax plus acetone; 11, wax only; 12, untreated.

Pontiac varieties free from defects were selected from bins in a commercial warehouse. One lot of each variety was stored at 80° F. in a thermostatically controlled cabinet until vigorous sprouts had developed on all tubers. The other lot was held in a dormant condition by storage at 36° to 40°. Prior to treatment, the sprouts were removed from the non-dormant tubers, and all tubers were thoroughly washed.

The chemicals were applied by dipping the tubers in wax emulsions diluted with distilled water to give the concentrations shown in table 2. Ten tubers were used for each treatment in the preliminary non-replicated experiment. The various lots were stored at an average temperature of 59° F. until May 31, 1950.

Weight losses due to sprout removal from dormant and desprouted non-dormant Triumph and Pontiac potatoes treated with MENA in wax are shown in table 2. The commercial wax emulsion (wax A) applied at the rate of 800 mg./kg. of potatoes provided a degree of sprout inhibition although some sprout growth did take place. Sprout growth was particularly noticeable on the non-dormant tubers of the Triumph variety (and to a lesser extent on Pontiac) from which sprouts had been removed prior to treatment.

TABLE 2.—*Weight losses due to sprout removal from dormant and desprouted non-dormant Pontiac and Triumph potatoes treated with 3 concentrations of MENA in wax on May 9 and stored at an average temperature of 59° F. until May 31, 1950.*

Wax	Wax Application Rate (Mg./kg. of Potatoes	MENA Application Rate (Mg./kg. of Potatoes)	Weight Loss (Per cent of Original Tuber Weight)			
			Triumph		Pontiac	
			Dormant	Desprouted Non-Dormant	Dormant	Desprouted Non-Dormant
None	0	0	1.45	1.34	2.79	3.86
A	200	Unknown	0.91	1.07	1.85	1.72
A	400	Unknown	0.35	0.68	1.09	0.88
A	800	Unknown	0.13	0.38	0.41	0.28
None	0	0	1.47	0.86	2.91	3.89
B	200	8	0.04	0.16	0.12	0.25
B	400	17	0.01	0.10	0.04	0.18
B	800	33	0.00	0.05	0.02	0.09

Many of the sprouts on the desprouted non-dormant tubers treated with wax A were more nearly normal in appearance than the short, much ramified sprouts typical of tubers treated with higher rates of MENA. This would detract from their market appearance and reduce their value.[3] As expected, decreasing the application rate and consequently the amount of sprout inhibitor allowed more sprouting.

Much more satisfactory sprout inhibition was brought about by the application of the paraffin-base wax (wax B) containing known amounts of MENA. This suggests that the quantity of sprout inhibitor in wax A was considerably less than in wax B. Less sprouting took place with MENA in wax B at 8 mg./kg. of potatoes than with A at the highest concentration used.

The lowest concentration at which entirely satisfactory sprout inhibition was brought about in both dormant and non-dormant Triumph and Pontiac potatoes by MENA was 17 mg./kg. However, very small amounts apparently result in some inhibition. At the recommended wax application rate of 1 gal./10,000 lb. of potatoes, an emulsion containing 2.1 per cent MENA would be required to apply the inhibitor at 17 mg./kg. Lots of the Triumph variety treated with either wax A or B showed less sprout growth than comparable lots of the Pontiac variety. The amounts

[3]When more than 10 per cent of any lot of potatoes have sprouts over ¾ inch long, the lot will not meet the requirements for U. S. No. 1 grade.

of sprout growth that occurred following treatment of the Triumph variety with the sprout-inhibitor waxes are shown in figure 3.

Treatment of Non-Dormant Triumph Tubers with Two Chemicals.—During the latter part of the 1951 shipping season certain phases of the problem were investigated more extensively. Lots of comparable potatoes of the Triumph variety were selected from two bins of a commercial warehouse. The potatoes from one bin showed no definite

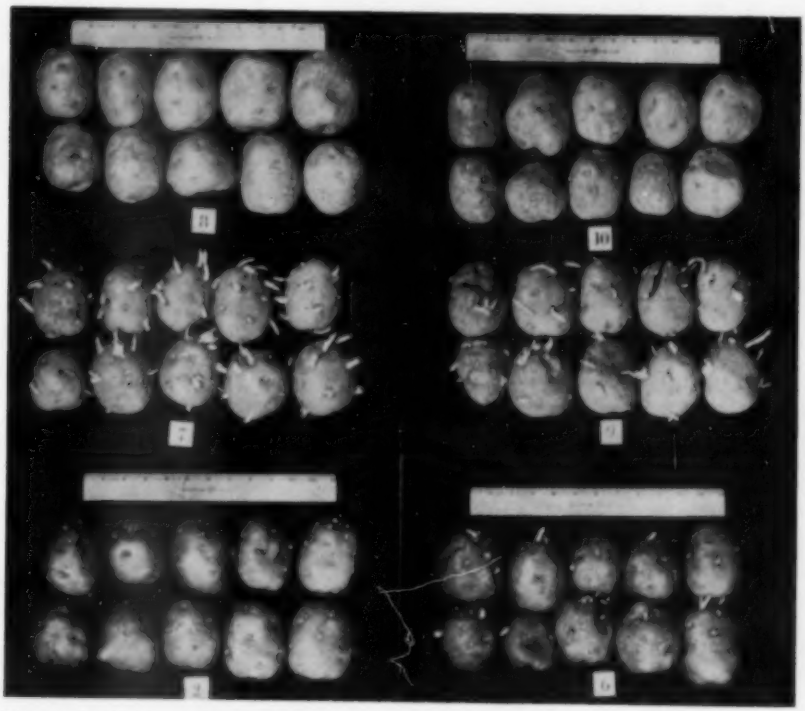

FIGURE 3.—Dormant and desprouted non-dormant potatoes of the Triumph variety treated with MENA incorporated in aqueous wax emulsions. *2*, *7*, and *8*, tubers dormant at time of treatment; *6*, *9*, and *10*, non-dormant tubers from which sprouts were removed prior to treatment; *2* and *6*, commercial sprout-inhibitor wax applied at the rate of 800 mg./kg. of potatoes; *7* and *9*, untreated; *8* and *10*, MENA at 17 mg./kg. of potatoes in paraffin-base aqueous wax emulsion.

sprout growth although they were no longer dormant, for close examination revealed that the buds had an average length of 2 mm. The potatoes from the other bin had been held at a higher temperature during the latter part of the storage season and possessed well-defined sprouts 15 to 25 mm. in length. These sprouts were removed prior to treatment. The two lots are referred to as unsprouted and desprouted, respectively.

Ten tuber samples of each of the two lots of potatoes were treated by immersion in the following emulsions or solutions: (1) an aqueous

emulsion of MENA, (2) a vegetable-base, aqueous wax emulsion of MENA, and (3) and aqueous solution of the diethanolamine salt of MH. The potatoes were treated on April 30 and stored at an average temperature of 59° F. until May 28, 1951.

Considering the effect of MENA applied in water emulsion, one sees that the least sprout growth occurred when MENA was applied at the rate of 33 mg./kg. of potatoes and that the next slowest sprout growth occurred when the chemical was applied at the two lower rates (Table 3). Significant differences between 33 and 17 mg./kg. MENA and between 17 and 8 mg./kg. are not indicated. However, when the data from these three treatments were analyzed separately, the differences due to treatment were found to be highly significant. The three concentrations of MENA in water caused about the same response in both unsprouted and desprouted tubers.

The responses of these potatoes to MENA at 17 mg./kg. in water and in wax were also examined separately. This separate analysis showed that the potatoes treated with wax plus MENA lost significantly less weight from sprout removal than those treated with aqueous emulsions of MENA, with odds greater than 99:1. This is not in agreement with the results of Marth and Schultz (7), who found the water dip to be slightly superior to the wax. The data are not strictly comparable, however, since there were differences in the kind of wax used as well as in chemical concentration and variety.

MH in aqueous solution applied as a dip proved ineffective in retarding sprout growth even at the highest concentration. Sprout growth in the desprouted potatoes treated with MH was in all cases less than in the unsprouted potatoes. This indicates that some of the chemical entered the tubers through the broken base of the sprouts. These data are in agreement with the results of Marshall and Smith (6), who found

TABLE 3.—*Weight losses due to sprout removal from unsprouted and desprouted Triumph potatoes treated with aqueous emulsions or solutions of 2 chemicals and stored at an average temperature of 59° F. from April 30 to May 28, 1951.*

Chemical	Application Rate (Mg./Kg. of Potatoes)	Weight of Sprouts (Per cent of Original Tuber Weight)		
		Tubers Unsprouted	Tubers Desprouted	Mean[1]
MENA in Water	8	1.00	1.03	1.01
MENA in Water	17	0.69	0.70	0.69
MENA in Water	33	0.29	0.30	0.29
MENA in Wax	17	0.16	0.43	0.30
MH in Water	15	4.33	2.50	3.42
MH in Water	30	5.12	2.83	3.98
MH in Water	90	3.60	2.14	2.87
Wax Only	....	4.88	2.94	3.91
None (Untreated check)	....	3.86	3.16	3.51
Mean	....	2.66	1.78	....

[1]L.S.D. at .05 level for chemicals = 0.49; at .01 level = 0.66

that a 2,500 p. p. m. dip treatment with MH was ineffective as a sprout inhibitor for dormant Green Mountain potatoes but that toothpicks previously soaked in the solution when inserted into the tubers completely inhibited sprout growth.

Summary and Conclusions

An account is given of experiments to determine the efficiency of alpha terpineol, alpha chloronaphthalene, methyl ester of alpha naphthaleneacetic acid (MENA) and maleic hydrazide (MH) applied in wax or water in inhibiting sprouting or potatoes during the latter part of the late-crop shipping season.

For a month excellent sprout inhibition of Triumph and Pontiac potatoes at an average temperature of 59° F. was obtained with MENA at the rate of 17 mg./kg. of potatoes. This rate is equivalent to a 2.1 per cent aqeous emulsion applied at the rate of 1 gal./10,000 lb. of potatoes. Although this treatment was more effective on tubers that were in an unsprouted condition, it was also satisfactory when applied to desprouted tubers. The material was more effective when applied in an aqueous wax emulsion than in water. Lower rates of application resulted in less effective sprout control. A commercial wax containing an undisclosed amount of sprout inhibitor was distinctly inferior.

Although alpha terpineol retarded sprout growth to some extent, it was far less effective than MENA.

Alpha chloronaphthalene applied in an aqueous wax emulsion at a concentration of 100 mg./kg. almost completely prevented sprouting of potatoes but caused some injury to the tubers. This chemical may be suitable for treating potato dump piles to prevent the spread of late blight.

MH was ineffective in retarding sprout growth when applied to potatoes as an aqueous dip.

Acknowledgment

The author wishes to express his appreciation to the following companies that supplied generous quantities of certain materials used in these tests: the American Cyanamid Company for supplying the emulsifiable MENA; S. C. Johnson and Sons, Incorporated, for furnishing a sample of sprout-inhibitor wax; the Naugatuck Chemical Company for furnishing the maleic hydrazide; and the Red River Valley Potato Growers Association for supplying the potatoes.

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EXPERIMENTS IN THE CONTROL OF VERTICILLIUM WILT OF POTATOES IN CONNECTICUT 1954[1]

PAUL E. WAGGONER AND GORDON S. TAYLOR[2]

Verticillium wilt of potatoes has been of increasing importance in the Northeast (1, 4, 7). This disease has caused severe reductions in yield, and made potatoes unfit for seed.

Verticillium infection was general in Connecticut in 1954 as shown by isolations of the pathogene from stems of Katahdin and Kennebec potatoes during July. However, ample rainfall in August and September probably prevented or obscured any severe yield losses from the disease

The control of wilt by planting less susceptible varieties, the use of wilt-free seed, and crop rotation have not been adequate. Therefore, chemotherapy was tested as a control for Verticillium wilt of potatoes on infested soil. Chemotherapy was tested because it has successfully controlled certain other wilt diseases (3). Further, greenhouse experiments (6) have indicated that the method is promising in the case of Verticillium wilt of potato. In addition, seed treatment was tested where a field had not been planted to potatoes recently.

CHEMOTHERAPY

Verticillium wilt symptoms first appear on the plants in the field during late July or early August. Therefore, inoculation must occur during June. Later inoculation should cause smaller losses because of the extended incubation period of the disease during warm weather. Therefore, we reasoned that useful control would follow if the plants could be made resistant during June and early July.

Five or 6 replicates of 15 foot, single row plots of certified Kennebec potatoes were planted April 22 and May 7 in commercial fields in Hartford County and April 30 at the Experimental Farm near New Haven. All 3 fields had a history of Verticillium wilt of potato. The pathogen was easily isolated from stems during the course of the 1954 experiments. The commercial field planted April 22 was the only one that received irrigation.

TREATMENTS

Growth regulators have generally made plants resistant to wilt (2). Therefore, one treatment was a single spray of 1000 ppm sodium salt of 2,4-dichlorophenoxyacetic acid (2,4-D) 40 days after planting.

Antibiotics have not generally provided useful control of fungal diseases. However, terramycin altered *Verticillium albo-atrum in vitro* and was tested in the field. The plants received 4 weekly sprays of 500 ppm terramycin HCl supplied by Chas. Pfizer Co., Inc. The sprays were begun 40 days after planting.

Growth regulators and antibiotics have been shown to act synergistically in the control of a plant disease (5). Therefore, a foliage spray of 2,4-D and terramycin was applied 40 days after planting.

[1]Accepted for publication January 19, 1954.

[2]Department of Plant Pathology, The Connecticut Agricultural Experiment Station, New Haven, Conn.

HD 469, a promising chemotherapeutant against Fusarium wilt of tomato, was sprayed on the foliage at four weekly intervals beginning 40 days after planting. A concentration of 1000 ppm was employed.

Two treatments with conventional fungicides were included. First, cut seed in one treatment was dipped for 5 minutes in a 3400 ppm suspension of zineb (Z-78). This seed treatment was not regarded as a chemotherapeutant but as a basis for comparison. Secondly, 4 gallons of 3250 ppm zineb (Z-78) suspension was poured into trenches in each 15-foot plot. The trenches were about 4 inches from the center of the hills and 2-3 inches deep. These trenches were dug on each side of the hill and closed after each treatment. Four weekly treatments were applied, the first 40 days after planting.

Results

Symptoms of *Verticillium* wilt were prevalent in all 3 fields by late July. The wilting and yellowing of foliage was estimated on the Horsfall-Barrett scale, (Table 1). The corresponding analyses of variance are given in table 2.

The single spray of 2,4-D severely distorted the plants, but they recovered and made rapid growth from July-September. The 2,4-D spray decreased wilt severity significantly in the 2 commercial fields, slightly in the severely diseased Experimental Farm replicates, and not at all in the moderately diseased Experimental Farm replicates. Terramycin and HD 469 spray and zineb seed and soil treatments did not alter wilt severity.

Table 1.—*Mean severity of wilting and yellowing of foliage estimated on the Horsfall-Barrett scale and comparisons of means.*

Planting Date or Comparison	Check	Treatment					
		2,4-D	Terra-mycin	2,4-D+ Terra-mycin	HD 469	Zineb Seed	Zineb Soil
April 22[1]	7.44	4.4	7.0	3.2	7.8	7.0	7.0
May 7[2]	2.2	1.2	1.8	1.0	2.6	1.8	1.6
April 30[3]	8.0	6.3	6.0	6.0	8.3	8.7	9.0
April 30[4]	2.3	2.3	3.7	2.3	2.0	3.0	4.3
Comparison: 2	+	—	+	—			
A	+	+	—	—			
2A	+	—	—	+			
H	+				—		
Z1	+2					—	—
Z2						+	—

[1]Five replicates in an irrigated, commercial field observed 112 days after planting.

[2]Five replicates in a commercial field, observed 82 days after planting.

[3]Three severely diseased replicates at Experimental Farm observed 110 days after planting.

[4]Three moderately diseased replicates at Experimental Farm observed 110 days after planting.

TABLE 2.—*Analyses of variance of Horsfall-Barrett scores of wilt severity.*

Source of Variation	DF[1]	Mean Squares for Experiments Planted			
		April 22	May 7	April 30[2]	April 30[3]
Total	34 or 20				
Replicates	4 or 2				
Treatment comparisons 4: 2	1	57.8**	4.05**	2.1	1.3
A	1	3.2	.45	4.1	1.3
2A	1	.8	.05	2.1	1.3
H	1	.4	.40	.2	.2
Z1	1	.5	.81[5]	1.4	3.6
Z2	1	0	.10	.2	2.7
Error	24 or 12	2.2	.22	2.3	1.4

[1]Greater degrees of freedom for April 22 and May 7, lesser for April 30.
[2]Severely diseased.
[3]Moderately diseased.
[4]See table 1 for definition of comparisons.
[5]Significant at 10 per cent level.

The tubers were dug, graded, and weighed. There was no consistent effect of treatment upon proportion of small or decayed potatoes. The total yields are given in table 3 and analyses of variance in table 4.

TABLE 3.—*Mean yield of tubers in pounds per 15 foot single row plot.*

Planting Date	Check	2,4-D	Terramycin	2,4-D+ Terramycin	HD 469	Zineb Seed	Zineb Soil
April 22[1]	32.4	25.9	26.9	26.7	34.7	33.3	28.7
May 7[2]	34.8	38.4	35.5	34.0	35.7	38.1	35.3
April 30[3]	28.4	23.6	29.7	24.1	28.4	26.4	27.2
April 30[4]	32.1	24.0	29.2	26.7	29.9	30.1	29.3

[1]Five replicates dug 155 days after planting.
[2]Five replicates dug 168 days after planting.
[3]Three severely diseased replicates dug 171 days after planting.
[4]Three moderately diseased replicates dug 171 days after planting.

The 2,4-D sprayed plants were severely distorted during June. Therefore, it is not surprising that the yields were reduced in three of the experiments, the one planted April 22 and the second planted April 30. In the experiment planted May 7, 2,4-D spray did not reduce yield. The 2,4-D must have influenced the yield in two ways: first, the distortion reduced yields and, secondly, disease control increased yield. It is possible that in these potatoes the second effect was of the same magnitude as the first because the plants were not irrigated and were not dug until 86 days after the disease observations. The other treatments did not consistently alter yields.

TABLE 4.—*Analyses of variance of yields.*

Source of Variation	DF[1]	Mean Squares for Experiments Planted			
		April 22	May 7	April 30[2]	April 30[3]
Total	34 or 20				
Replicates					
Treatment comparisons 4: 2	1	57.5[5]	5.8	81.1**	83.2**
A	1	27.1	17.3	2.6	0
2A	1	48.9[5]	33.3[5]	.5	24.1[5]
H	1	12.8	2.4	0	3.6
Z1	1	6.1	12.5	5.1	11.8
Z2	1	53.8[5]	20.2	.8	1.0
Error	24 or 12	16.3	8.7	6.7	7.1

[1]Greater degrees of Freedom for April 22 and May 7, lesser for April 30.
[2]Severely diseased.
[3]Moderately diseased.
[4]See table 1 for definition of comparisons.
[5]Significant at 10 per cent level.

SEED TREATMENT

Certified Kennebec seed potatoes showing considerable stem end discoloration were cut and subjected to various treatments before being planted in a field that had been fallow or in cereals for four years. This rotation should free the soil of infestation (8). The cut seed were dipped for 5 minutes in water solutions or suspensions, drained, and stored for 5 days at 40-50° F. in well-ventilated bags. In addition to a water check, the treatments were 3400 ppm zineb (Z-78), 16,666 ppm Semesan Bel, 3640 ppm maneb (Manzate), 2440 ppm sodium salt of dimethyl dithiocarbamic acid and 213 ppm sodium salt of 2-mercaptobenzothiazole (Vancide 51), and 3900 ppm polyethylenebisthiuram trisulfide (Lo-738). Further, the zineb treatment was applied to seed free of stem end discoloration (8).

The seed was planted April 20. After 43 days plants had emerged from 95 per cent of the seed pieces. There were no consistent differences in emergence between treatments. *Verticillium albo-atrum* was isolated from discolored stems in the plots. However, there were no consistent differences between treatments in wilt symptoms 100 days or in yield 161 days after planting. Apparently none of the treatments controlled wilt or injured the plants.

CONCLUSIONS AND SUMMARY

Attempts were made in the field to control Verticillium wilt of potato. Chemotherapeutants were employed in infested fields and seed treatments in a field in which Solanaceous plants had not been grown for four years. Of the several treatments tested, only an early foliage spray of a high concentration of a growth regulator causing temporary distortion gave a reduction in symptoms. The reduction was significant in two fields, small in one, and *nil* in one field. This treatment caused a 17-25 per cent

reduction in yield in three fields and a non-significant increase in yield in the fourth field.

These experiments indicate that growth regulators may be developed into useful chemotherapeutants for Verticillium wilt of potato. This is particularly important because of the lack of satisfactory control methods at the present time.

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A NEW STRAIN OF THE POTATO LEAF ROLL VIRUS[1]

R. E. WEBB[2]

An isolate of the leaf roll virus was recovered from severely diseased plants of the resistant potato seedling X927-3. This isolate consistently produced mild symptoms of leaf roll in plants of Katahdin and potato seedling 41956 (Figure 1). The X927-3 isolate of the virus appeared to have an unusually long incubation period (46-62 days) in these hosts (6). The known virus strains have an incubation period of some 20-30 days and induce moderate to severe symptoms of leaf roll in plants of most potato varieties. The X927-3 isolate from either severely diseased plants of seedling X927-3 or infected plants of Katahdin and seedling 41956 induced similar responses in the indicator host, *Physalis floridana* Rybd. These symptoms were mild plant stunting, moderate leaf chlorosis and slight to moderate petiole twisting and epinasty. Except for a slight delay in appearance, the response of this host to infection with the X927-3 isolate was indicative of that induced by strain 1 of the leaf roll virus.

The X927-3 isolate appeared to differ from the known virus strain in its long incubation period and the mild symptoms it induced in 2 potato varieties. Comparative studies of the X927-3 isolate and strain 1 were initiated since they induced similar symptoms in the indicator host, *P. floridana*, but differed in other respects. Strains 2, 3, and 4 were not included in these studies, since a previous report (5) had indicated them to have an incubation period similar to that of strain 1 and to differ principally in virulence on the indicator host and certain potato varieties.

MATERIAL AND METHODS

Sources of the leaf roll virus were infected plants of Katahdin and potato seedling X927-3. Young plants of *P. floridana* were used as the indicator host for the virus (2). Differential hosts for strain identification were Katahdin potato and *Datura stramonium* L.

The green peach aphid, *Myzus persicae* (Sulz.) was used as the insect vector. Virus-free colonies were maintained on young broccoli plants in insect proof cages.

In each series of inoculations the virus acquisition and infection periods, unless otherwise stated, were each 3 days. Ten viruliferous aphids were placed on each of 5 test plants of a series. The aphids were confined to the individual test plants with pliofilm cages. A contact insecticide was used to kill the aphids after each infection period and to prevent spread of the virus.

RESULTS

Host Reaction.

Grafting to and aphid-transmission studies on potato showed the difficulty in transmitting the leaf roll virus from diseased plants of potato

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FIGURE 1.—Potato seedling 41956 infected with the leaf roll virus by core-graft inoculations. Symptoms induced: left, by strain 1; right, by X927-3 isolate.

seedling X927-3 (6). Susceptible hosts which were more favorable for recovering this isolate were sought for comparative transmission studies with virus strain 1. Five healthy plants each of *P. floridana* and of Katahdin potato, which are excellent hosts for virus strain 1, were colonized with aphids that had fed 6 days on leaf-roll-infected plants of potato seedling X927-3. A similar series were inoculated with virus strain 1. As soon as the initial symptoms of leaf roll appeared on infected plants, 2 plants of each host were colonized with virus-free aphids. After a 2-day acquisition period, the aphids from each plant were transferred to healthy *P. floridana* plants for a 3-day feeding period. Similar sub-transfers of the virus from these hosts were conducted at weekly intervals over a 3-week period. The initial trasmission attempts indicated that plants of *P. floridana and D. stramonium* were more favorable hosts for strain 1 than for the X927-3 isolate. Katahdin potato appeared to be an excellent host for both strain 1 and the X927-3 isolate. Seven days after symptoms appeared in infected plants of *P. floridana*, the X927-3 isolate could be recovered as readily as strain 1. However, 21 days after initial symptoms

FIGURE 2.—Plants of *Datura stramonium*, etc.

had appeared in infected plants of *D. stamonium*, this species was still a poor source of the X927-3 isolate. Later tests indicated that this isolate could be recovered only from leaves showing distinct symptoms of leaf roll. Symptoms induced in this host by the X927-3 isolate developed very slowly (Figure. 2).

Potato varieties Russet Burbank, Red Warba, Chippewa, and Katahdin and potato seedling 41956 and X927-3 were selected to determine their relative susceptibility to virus strain 1 and the X927-3 isolate. Six plants of each variety were colonized with viruliferous aphids from each source when they were about 1 inch tall. All varieties except seedling X927-3 were more resistant to infection with the X927-3 isolate than with strain 1. Conversely, seedling X927-3 was more susceptible to the X927-3 isolate

TABLE 1.—*Susceptibility of Katahdin and potato seedlings X927-3 and 41956 to leaf roll virus strain 1 and the X927-3 isolate*

Variety	Plants Inoculated		Plants Infected		Period before Appearance of Symptoms	
	Strain 1	X927-3 Isolate	Strain 1	X927-3 Isolate	Strain 1	X927-3 Isolate
	Number	Number	Number	Number	Days	Days
Katahdin	15	15	15	12	22-27	36-47
X-927-3	15	15	7	11	27-31	32-47
41956	15	16	15	14	25-34	29-38

than to strain 1. Table 1 shows the results of a second varietal infection test, in which essentially the same results were obtained as in the first experiment.

Varietal Reactions.

Varietal reaction to infection with the identified leaf roll virus strains is variable but follows a rather consistent pattern (5). When very young potato plants are inoculated with these, transit apical leaf rolling and leaf pigmentation indicative of current-season infection are seldom expressed. Usually the plants develop basal leaf chlorosis, cupping, and rolling 20-30 days after infection. These symptoms rapidly spread to the middle and upper leaves in most potato varieties (Figure 1). In the varietal susceptibility trials with strain 1 and X927-3, the initial symptoms expressed by plants of Red Warba, Chippewa, Katahdin, and potato seedling 41956 infected with strain 1 were typical of those just described. Two of 6 plants of Russet Burbank infected with strain 1 developed mild transitory apical leaf rolling with some pigmentation. These symptoms disappeared and were followed rapidly by typical basal symptoms of leaf roll. Plants of potato seedling X927-3 infected with strain 1 were very severely stunted and chlorotic. Slight basal leaf rolling appeared and dwarfed axillary shoots developed in the lower leaf axils.

Symptoms induced by the X927-3 isolate of the virus varied in degree but were similar in infected plants of all varieties. Invariably infected plants initially developed slight chlorosis and stunting of the upper 4 or 5 leaves. These initial apical symptoms, though moderately intensified, were the only signs of virus infection in plants of Red Warba and potato seedling 41956 and X927-3 57 days after infection. Severe apical leaf rolling and pigmentation gradually replaced the chlorosis in the upper 4 or 5 leaves of most infected plants of varieties Russet Burbank, Chippewa, and Katahdin (Figure 3). These symptoms, which are characteristic of late current-season leaf roll infection in some potato varieties, remained localized in the upper 4 or 5 leaves 57 days after infection. Although the virus could be recovered from the middle and lower leaves of plants showing the severe apical leaf rolling, no leaf rolling and cupping developed in them. Sub-transfers of the X927-3 isolate and strain 1 from infected plants to healthy plants of Katahdin and potato

FIGURE 3.—Plants of potato variety Katahdin. Left, healthy; right, with apical leaf rolling induced by the X927-3 isolate 47 days after inoculation. (Note, plants were purposely wilted to show extent of leaf rolling.

seedling 41956 induced symptoms characteristic of those following the original inoculations.

A similar test, in which plants of varieties Russet Burbank, Katahdin, Red Warba, and Chippewa were inoculated in the full-bloom stage, produced similar results.

Incubation Period.

All plants infected with virus strain 1 developed characteristic leaf roll symptoms 22-34 days after inoculation. Apical leaf chlorosis and stunting induced by the X927-3 isolate appeared 28-34 days after inoculation in varieties Red Warba and potato seedling 41956 up to 47 days in Katahdin and potato seedling X927-3. These symptoms were difficult to detect in some plants of the last two varieties 57 days after plant inoculation. Sub-inoculations from these plants to the indicator host verified the presence of the virus. Apical leaf rolling and anthocyanin development were as variable as the initial symptoms of infection.

Cross-Protection Test.

Cross-protection tests indicate that the X927-3 isolate will protect infected plants of *P. floridana* and Katahdin from re-infection with strain 1. Identity of the strain present in re-inoculated plants was verified by sub-transferring the virus to healthy plants of Katahdin.

Discussion

The leaf roll virus isolated from diseased plants of potato seedling X927-3 consistently produced in the indicator host *Physalis floridana* mild symptoms characteristic of strain 1 (mild). However, the X927-3 isolate of the virus became systemic very slowly in infected plants of *Datura stramonium*. Sub-transfers of the virus at weekly intervals from infected plants of *P. floridana* indicated that the X927-3 isolate did not multiply as rapidly as strain 1 in this host. Infected Katahdin potato plants proved to be a good source of the X927-3 isolate and of strain 1.

Symptoms induced in infected potato plants by the X927-3 isolate differed from those characteristic of leaf roll infection. Plants of Red Warba and potato seedling X927-3 and 41956 did not develop characteristic symptoms of leaf roll 57 days after infection. Some infected plants of Katahdin responded similarly. However, most of these plants and those of Russet Burbank and Chippewa developed severe stunting, leaf rolling, and anthocyanescence in the apical 4 or 5 leaves. These symptoms were similar to those of initial infection by the purple-top virus (1) and apical leaf roll virus (4). The underground symptoms characteristic of the last two diseases have not been noted in plants infected with the X927-3 isolate of the virus. The persistence of the apical symptoms and lack of basal leaf rolling and cupping in infected plants differ distinctly from symptoms induced by the 4 strains of the leaf roll virus (5). The X927-3 isolate of the virus apparently moves downward in infected plants since the virus could be recovered from the lower leaves of plants showing either the apical stunting and leaf chlorosis or the persistent apical leaf rolling and anthocyanin pigmentation.

The erratic incubation period of the X927-3 isolate differs from that of virus strain 1. Young potato plants infected with strain 1 usually show symptoms 20-30 days after inoculation. Plants infected with the X927-3 isolate developed initial symptoms over a period of 29-47 days (Table 1). Fifty-seven days after inoculation some plants of Katahdin had not developed apical leaf rolling and the chlorotic symptom in these plants was very mild. Definite diagnosis of the disease in these plants as well as in the plants of potato seedling X927-3 was dependent upon sub-transferring the virus to the indicator plant.

The expression of the apical leaf roll symptom in plants infected with the X927-3 isolate appeared to be correlated with the susceptibility of plants to branch-trace necrosis (3). Infected plants of Katahdin, Chippewa, and Russet Burbank which showed apical rolling manifested severe branch-trace necrosis, whereas this symptom was not evident in infected plants of Red Warba and seedlings 41956 and X927-3.

These studies have shown that the X927-3 isolate of the leaf roll virus differs materially from strain 1. The X927-3 isolate has an erratic, usually long, incubation in plants of some potato varieties and does not become systemic readily in *D. stramonium*. Some potato varieties appear to be resistant to infection with this isolate, and at least one seedling was more susceptible to it than to strain 1. Also, this isolate induced leaf roll symptoms which remain localized in the apical portion of the plant for a long period. Since the other identified strains of the leaf roll virus (5)

produced symptoms which differ only in degree from those induced by strain 1, it is proposed that the X927-3 isolate be known as leaf roll virus strain 5.

Summary

Comparative studies of strain 1 (mild) of the leaf roll virus and an isolate from diseased plants of potato seedling X927-3 were made. These studies show the X927-3 isolate of the virus to differ from strain 1 in its rate of becoming systemic *Datura stramonium* in the degree of symptom development, and in the erratic incubation period in potato varieties Katahdin, Chippewa, Red Warba, Russet Burbank, and potato seedling X927-3 and 41956. Cross-protection tests indicate that the X927-3 isolate of the virus will prevent reinfection of infected potato plants with strain 1. It is proposed that the X927-3 isolate of the virus be known as strain 5 of the leaf roll virus.

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SOME NEW FINDINGS CONCERNING *PHYTOPHTHORA INFESTANS* (MONT.) DE BY.[1]

J. L. HOWATT AND P. N. GRAINGER[2]

In a paper presented at the 40th Annual Meeting of the Potato Association of America, 1953, Howatt and Hodgson (4) on the basis of limited experimental evidence, reported finding a race of *P. infestans* which was destructive to all the then available European and American potato differentials, varieties and blight-resistant seedlings. These data indicated that race (1, 2, 3, 4) had made its appearance in the field at Fredericton, New Brunswick, Canada. Furthermore, it was reported that some strains of *Solanum demissum* Lindl. were resistant to this race and it was assumed that these possessed at least a fifth protective gene.

At the time the paper was written only ten of Black's potato differentials were available, hence, some doubt was entertained concerning the conclusions. Since the presentation of that paper a full set of Black's genotypes became available from the Scottish Plant Breeding Station. Seven of those used by Mills and eight of Mastenbroek's differentials were also obtained from the Inter-Regional Potato Introduction Station in the United States. Repeated tests with all these differentials have revealed their complete susceptibility to this race, thus confirming the original contentions. In that paper some reference was made to the current methods and facilities available for blight testing. Because of the importance of these features of the work, further details seem to be warranted.

Two chambers and a special cool room are available for blight testing at this center. The old blight chamber which is of single glass, uninsulated construction, is housed in greenhouse number 1. It is automatically controlled with respect to both maximal temperature and humidity. The temperature, although never allowed to exceed 70° F. is free to develop the lower temperatures which may prevail in the greenhouse. The humidity is maintained by 6 down-directed spray nozzles, which operate from a one-inch water main under control of a time clock. Sprayings of 15-60 seconds duration, according to the setting, are delivered every hour. The spray nozzles are manufactured by the Spray Engineering Company, Somerville, Massachusetts, under number 1116M. When operating at full capacity the system is capable of delivering moisture, equivalent to approximately 0.7 inches of rainfall per day. Some details of the construction of this chamber are given in figure 1.

The new blight chamber is of double glass, insulated construction throughout. It is housed in the potting shed of greenhouse number 2. This chamber is equipped with humidity and temperature controls and an artificial lighting system of fluorescent tubes numbering 24 in all. The details of the construction of this chamber are given in figure 2.

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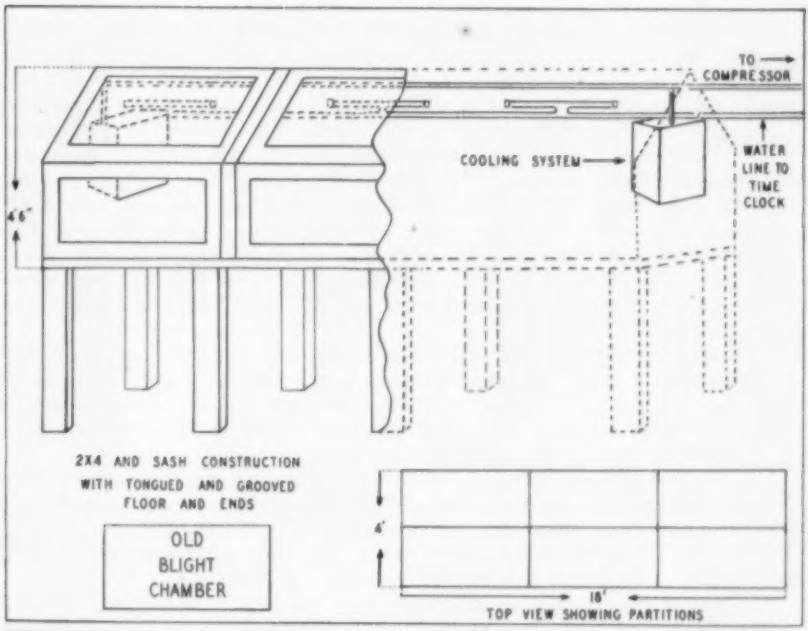

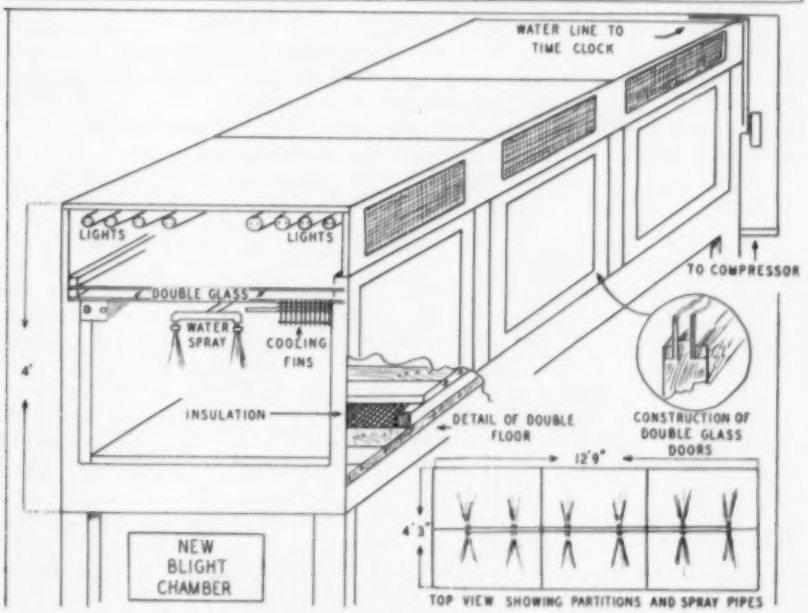

FIGURE 1.—Sketch of old blight chamber (top).
FIGURE 2.—Sketch of new blight chamber (bottom).

Both blight chambers are cooled by ½ H.P. compressors which operate blower coils in chamber number one and fin-gravity coils in chamber two. The floor of each blight chamber is overlaid with glass wool batts which retain some of the water sprayed on them by the humidifying system. The composition of the batts discourages the growth of micro-organisms. Each blight chamber is divided into sections by means of wooden frames covered with polyethylene film. The purpose of this sectioning is to permit working with more than one race at a time by reducing to a minimum chances of cross-contamination of cultures. Experience has shown that it is desirable to work in the blight chambers and cool room on different days or simultaneously with different personnel. For the same reason only one door of a blight chamber is opened at any given time.

The individual sections of each chamber are capable of housing two or three trays, approximately 20 inches square and 3 inches deep. Each tray has a phosphor-bronze screen bottom and a cover of polyethylene film. The cover material has relatively little effect on light transmission. The trays are lined with water-soaked sphagnum moss.

The cool room is an insulated portion of the basement, equipped with fluorescent lighting. At the present time this chamber is not artificially cooled but it has maintained a temperature favorable for its purpose. In this room all testing work is done with detached leaves in enamel trays each of which is covered with a sheet of glass.

One of the phases investigated was the effect of various colored potato leaves on the development of *P. infestans*. The leaves utilized constituted a series extending from fully green specimens to those totally yellow or orange in color. These were inoculated but once and read six days after inoculation At the termination of this period, examination revealed that the fungus fruited on any portion of the leaf blade which possessed functioning green portions but it failed to fruit on the yellow or orange areas. Table 1 summarizes the results of many trials.

The data suggest the necessity of living tissue if growth of the organism is to be sustained.

Of further interest was the effect of freezing potato leaves on the development of the fungus. In four experiments, leaves were inoculated and left in the blight chamber until their general darkening heralded the development of aerial fructifications of the fungus. The leaves were then taken out, frozen and replaced in the blight chamber to thaw. Following this they were re-inoculated with *P. infestans*. After the lapse of ten days the foliage was again examined for evidence of fructifications but none developed on the thoroughly frozen leaves. In a few instances, however, the fungus fruited weakly on tissues not wholly destroyed by the exposure to freezing temperatures. In time various saprophytic fungi made their appearance on most of the leaves.

In another series of experiments Green Mountain leaves were frozen, thawed, and inoculated just before being placed in the blight chamber. The results were similar — the fungus failed to develop. Somewhat similar data were reported by DeBruyn (2) for sterilized green tissue.

In further experiments, inoculated Green Mountain leaves were placed on the surface of air-dried Vermiculite contained in trays housed in

TABLE 1.—*Growth of P. infestans on senescent potato leaves.*

Variety	No. Leaflets Inoculated	Descriptions	Remarks
		Per cent Per cent	
Green Mountain	32	100 Yellow	None
Green Mountain	19	90 Yellow—10 Green	Slight
Green Mountain	32	100 Yellow	None
Green Mountain	13	65 Yellow—35 Green	Moderate
Green Mountain	20	65 Yellow—35 Green	Moderate
Chenango	12	100 Yellow	None
Chenango	5	95 Yellow— 5 Green	Very slight
R. Burbank	15	100 Yellow	None
R. Burbank	13	50 Yellow—50 Green	Severe
Menominee	8	100 Yellow	None
Menominee	6	90 Yellow—10 Green	Slight
Early Gem	14	100 Yellow	None
Early Gem	7	95 Yellow— 5 Green	Very slight
Pungo	20	95 Yellow— 5 Green	None
Pungo	3	90 Yellow—10 Green	Slight
King Edward	4	100 Yellow	None
King Edward	2	95 Yellow— 5 Green	Very slight
Arran Comrade	16	95 Yellow— 5 Green	None
Minota	6	65 Yellow—35 Green	Moderate

the blight chamber. In many trials the fungus failed to fructify. This result was surprising in view of the high humidity maintained in this chamber.

In a series of experiments designed to test the rapidity of spore formation following leaf brushing, it was interesting to note that spores invariably developed earliest and in the greatest profusion on that side of the leaf in contact with the moss in the trays. This feature was constant whether the leaves were right-side-up or up-side-down. In these experiments it appeared as if the new crop of spores developed in portions of green tissue adjacent to a darkened area which had previously borne spores. If the spore-bearing cells were exhausted of their nutrients by previous fructifications no further development of the fungus seemed possible from these areas. On the other hand, if cells were not completely depleted by the fungus, it was possible for a second crop of conidia to develop on these areas. Spore formation after brushing seldom occurred in less than eight hours on Green Mountain leaves maintained in the blight chamber between 56° and 68° F. Wallin (5) has shown that spores are regenerated more rapidly at higher temperatures.

In the month of November, 1953, over ten thousand individually potted *S. demissum* x *S. tuberosum* seedlings were inoculated with a race of *P. infestans* which had been determined once as race 0. Some weeks after their first inoculation, it was noticed that more than the usual number of susceptible plants was being encountered. Shortly after this finding the seedlings were sampled, and the inoculum was then found to contain many races of the fungus. Eventually all the seedlings succumbed to infection and in further testing, race (1,2,3,4) was thought to be present. At first it was suggested that in some unaccountable manner this race had been introduced on the clothing of personnel from an adjacent

greenhouse where this culture was being propagated. It was difficult to accept this explanation, however, because of the cold weather which was being experienced outdoors, and in the light of present knowledge, it is considered incorrect.

In the month of February, 1954, a race of blight was secured from the United States as race (1) of *P. infestans*. Prior to working with this race, the old blight chamber and its accessories were washed with 5 per cent formalin and dried out for a period of eight days. The race was then tested twice on Black's differentials without registering on any one of them. However, when tested the third time it registered on Pentland Ace. In further trials, it registered as race (4) on March 31, and as race (3) on April 9. During this period the culture never registered on 835a(4) but it infected Essex five times. Because of the temporary unavailability of the Essex variety it was not tested again until May 26, when in trials extending to July 7, it failed to register on this host. In the meantime, however, it registered on Pentland Ace and 1563c(14). In a test conducted between July 2 and July 9 this culture was placed on a full set of Black's differentials, as well as on nine of Mills' and eight of Mastenbroek's hosts. In this test genotypes 1563c(14), DXD-3 and 4431-5 succumbed to infection, indicating that the fungus had registered uniformly on all three sets of differentials as race (4). The same detached leaves were kept in the blight chamber, re-inoculated from the Green Mountain carrier and read again July 16. In this test all fifteen genotypes with the exception of 1512c(16) and Pentland Ace succumbed in Black's series, while only DXD-3 and 4431-5 succumbed in the other series. During these trials, Mills' differentials were somewhat chlorotic because of early maturation. Attention is drawn to the susceptibility of genotype 2070(30) which allegedly carries four genes and to the apparent resistance of 1512c(16) and Pentland Ace, possessing but one gene each. After the growth which had appeared on 2070(30) was transferred to this same host and to the Green Mountain variety, the fungus succeeded in completely destroying the inoculated leaves in six days. When inoculum was taken from these leaves, 2070(30), and inoculated to the full set of Black's and Mastenbroek's differentials on July 23, all these genotypes were infected when read on July 28. The results of this investigation as given in table 2 are most revealing. They challenge the concept of genotypic equivalency for at least some of the differential hosts enumerated in the International System and question the status of certain genotypes. Certainly, they make it difficult, if not impossible, to designate a race from a few tests on a set of differentials. Furthermore, they show that a specialized race may be developed on a recessive host.

In connection with the results shown in table 2, it should be borne in mind that only this culture was being maintained in the blight chamber during the period designated. During all this time every conceivable precaution was exercised to preclude contamination of the isolate. In addition it should be noted that the inoculum was always freshly derived from Green Mountain carrier foliage.

There became available during the progress of these tests isolates designated as monosporous zoospore cultures. These had their origin in the Netherlands and Canada and are identified throughout this paper as cultures K52, K22 and K45. These cultures were maintained in the

TABLE 1.—*Reactions of an alleged race (1) of P. infestans.*

Host	Reaction															
G. M.	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
835a(4)	..	..	..	..	..	..	..	..	..	..	..	..	..	x	..	x
Essex	..	..	..	..	x	x	x	x	x	..	..	..	..	..	..	
1512c(16)	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	x
P. Ace	..	..	x	..	..	..	..	..	x	x	..	x	..	..	..	x
1563c(14)	..	..	..	x	..	..	..	x	..	..	x	x	x	x	..	x
1647b(1)	..	..	..	..	..	..	..	..	..	..	..	..	..	x	..	x
1667b(7)	..	..	..	..	..	..	..	..	..	..	..	..	..	x	..	x
1506b(9)	..	..	..	..									..	x	..	x
1682c(1)	..	..	..	..									..	x	x	x
2070ab(31)	..	..	..	..									..	x	..	x
1584c(10)	..	..	..	..									..	x	..	x
2070(64)													..	x	..	x
2070(69)													..	x	..	x
2070(51)													..	x	..	x
2070(50)													..	x	..	x
2070(30)													..	x	..	x
43154-5													..	..	..	x
44158-4													..	..	..	x
4737-33													..	..	..	x
4431-5													x	x	x	x
4651-2													..	..	..	x
4739-58													..	..	..	x
46174-30													..	..	..	x
4414-2													..	..	..	x
DXD-3													x	x		
Inc. Period Days	6	7	6	7	6	7	5	6	11	7	7	6	7	14	6	5

x = Susceptible .. = Resistant G. M. = Green Mountain P. Ace = Pentland Ace

special cool room. This room was not equipped with an automatic water spraying system; consequently, the trays containing detached leaves were watered usually at the time the dry moss was put in them. When these cultures were inoculated to their respective hosts, care was taken to uncover only that tray being inoculated at the moment. When this task was completed the technicians thoroughly washed their hands with soap and water, before handling another culture. All the infected leaves were discarded into a five per cent solution of formalin where they remained for some days. Despite all these precautions evident changes were registered by the three cultures in respect to the hosts attacked. Table 3 summarizes the results obtained with these cultures.

Inspection of the table reveals that similar types of variations are being registered by each culture. Not only was there a divergence in the number of days required for fruiting on the genotypes, but there was also a dissimilarity in the genotypes attacked. This makes it extremely difficult to separate or identify races. Similar results have been reported by DeBruyn (3), who was of the opinion that the fungus was plastic. While not subscribing to DeBruyn's conclusions, the authors are of the opinion that more extensive work is required before the International System of Designating the Interrelationship of Genes and Races (1) is firmly established.

TABLE 3.—*Three monosporous cultures of P. infestans on differentials for various periods of time.*

Differential Hosts				Culture K52						Culture K22						Culture K45					
Genotype	Scot.	U. S.	Neth.	Scot.		U. S.		Neth.		Scot.		U. S.		Neth.		Scot.		U. S.		Neth.	
r	G. M.	G. M.	G. M.	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
R_1	835a(4)	Essex	43154-5	x	x	x	x	..	x	..	..	..	x	..	..	..	x	..	..	..	..
R_2	1512c(16)	3AB2	44158-4	..	..	x	x	..	x	x	x	x	x	x	x	..	..	x	x	..	..
R_3	P. Ace		4737-33	..	..			..	..	x	x			..	x	x	x			..	..
R_4	1563c(14)	DXD-3	4431-5	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
R_1R_2	1647b(1)	3XE-1	4651-2	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
R_1R_3	1661b(7)		4739-58	..	x			..	..	..	..			..	..	..	..			..	..
R_1R_4	1506b(9)	3WM-19	46174-30	..	..	x	x	..	..	..	..	x	x	..	..	..	..	x	x	..	..
R_2R_3	1682c(1)			..	..			..	..	..	..			..	..	..	..			..	..
R_2R_4	2070ab(31)	T1-5	4414-2	..	..	..	..	x	x	..	..	x	x	..	x	..	..	x	x	..	..
		3XX-4				x	x					..	..					x	x		
R_3R_4	1584c(10)			..	..					..	x					..	..				
Incubation Period/Days				7	9	7	9	7	9	6	8	6	8	6	8	6	8	6	8	6	8

Scot. = Scotland U. S. = United States Neth. = Netherlands G. M. = Green Mountain
P. Ace = Pentland Ace x = Susceptible .. = Resistant

Finally some mention should be made of the behavior of the varieties and species so far tested against race (1,2,3,4). A number of wild species have been segregated whose seedlings have shown resistance in three separate tests. No commercial potato varieties or seedlings have, to date, proved resistant. Tables 4 and 5 show the results obtained with some species and hybrids which were tested only once in the original seed pans. For this reason, the data given are only approximate and may not indicate the relationship established for resistance.

These tables may serve as a guide, however, to indicate the relative susceptibility or resistance of stocks. Most of the materials were made available through the courtesy of the Inter-Regional Potato Introduction Station at Sturgeon's Bay, Wisconsin. It is interesting to note in table 4 that a selection of *S. demissum* number S74 from Mexico, reported to possess a fifth gene, is heterozygous for resistance to this race.

SUMMARY

This paper records the findings of experimental work conducted during the past six months on various phases of investigation relative to the development and behavior of *P. infestans* (Mont.) De By.

The present paper confirms the existence of race (1,2,3,4).

Improvements in the blight testing technique and apparatus are described.

TABLE 4.—*Reaction of various* SOLANUM *species to race (1,2,3,4)*

Number	Species	No. Inoculated	No. Resistant
160220	*Solanum demissum*	30	0
160221	" "	60	59
160222	" "	8	0
160229	" "	109	105
161151	" "	50	34
161153	" "	40	0
161154	" "	5	0
161155	" "	55	0
161169	" "	50	45
161175	" "	65	61
161176	" "	50	46
161180	" "	50	40
161181	" "	50	42
161366	" "	50	47
161367	" "	65	3
161686	" "	110	0
161693	" "	40	25
161701	" "	25	0
161725	" "	40	20
161729	" "	25	23
161731	" "	70	63
161732	" "	30	13
175404	" "	45	15
175408	" "	20	0
175444	*Solanum polydenium*	15	15
S74	*Solanum demissum*	36	25

TABLE 5.—*Reaction of various* SOLANUM *hybrids to race (1,2,3,4)*

Number	Hybrids	No. Inoculated	No. Resistant
161150 x 189219	*S. stoloniferum* x *S. Schickii*	11	0
161152 x 195167	*S. stoloniferum* x *S. Malinchense*	3	1
186555 x 195164	*S. ajuscoense* x *S. Antipoviczii*	38	22
189215 x 195185	*S. gibberulosum* x *S. gigantophyllum*	24	0
195164 x 161152	*S. Antipoviczii* x *S. stoloniferum*	15	3
195164 x 186546	*S. Antipoviczii* x *S. boreale*	24	13
195164 x 195185	*S. Antipoviczii* x *S. gigantophyllum*	6	0
195167 x 161152	*S. Malinchense* x *S. stoloniferum*	7	0
	(*S. demissum* x *S. Rybinii*) x Canso	6	0
	3AB-2 x 1256a(23)	8	0
	Canso x Keswick	7	0

Information relative to the behavior of the fungus under definite environmental conditions has established some obscure host-parasite relationships of the organism.

Evidence is presented to show that certain differential hosts proposed in the International System, possibly, are not genotypic equivalents. The difficulties of designating races by this System are indicated.

The erratic behavior of monozoosporous isolates is attributed to discriminatory faults in the differential series rather than to heterogeneity in the isolates.

The results of testing some parental materials and hybrids with race (1,2,3,4) are presented.

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NEWS AND REVIEWS

CONSUMER ACCEPTANCE OF POTATOES OF VARIOUS QUALITIES[1]

CHARLES H. MERCHANT[2]

I presume the subject of consumer acceptance of specific gravity separated potatoes has been presented in an earlier session of this conference by Dr. Rasmussen of Cornell. Therefore, it seems unnecessary for me to report on Maine's two years experiences on consumers' response to specific gravity separated potatoes although it would be interesting to see how closely we are in agreement with Cornell.

CONSUMERS LOOKING FOR BETTER QUALITY POTATOES

Consumers in Maine and Boston, Massachusetts are not satisfied with the potatoes usually found on the grocery shelves. When potatoes are better sized, have less external defects, possess better cooking qualities, are washed, or are packaged in plastic containers, consumers shift from regular stock to the specially prepared potatoes and express real satisfaction. Hence, it is most difficult through experimental sales to segregate the importance of each of these many factors. We have long realized this situation and have approached the problem in piece-meal fashion keeping research on as nearly a practical basis as possible.

In Maine we feel that experimental sales of specific gravity separated potatoes have accomplished much in making growers, shippers, and consumers more conscious of the variations in cooking and eating qualities of potatoes. It has been a very important educational program which will have an influence on varieties grown, cultural practices and improved methods of marketing. This should be a stimulus to plant breeders in the development of varieties which more nearly meet the requirements of consumers of tomorrow. With larger scale operations at shipping points in the future, specific gravity separation is likely to become an important step in the "factory" operations. We may ask ourselves, is the potato industry ready to accept specific gravity separated potatoes without some intermediate steps and before the development of the so called "factory" operations? It has taken about five years of research on washing potatoes before the Maine potato industry really accepted the change. Specific gravity separation is more complicated and presents many more problems than just washing potatoes. Then, how many years can we expect to elapse before this practice is accepted?

TWO ADDITIONAL STUDIES UNDERWAY

I believe there are some intermediate steps which are necessary and which should be taken at this time. Maine is in the process of conducting two studies. One study is based on the practicability of separating washed U. S. No. 1 potatoes in two lots. One is a U. S. Fancy and the other

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a low grade U. S. No. 1. Retail store sales began in Boston this last Monday, November 15, 1954, and will continue for eight weeks in eight supermarkets. The other study dealing more specifically with internal qualities of potatoes began last season. It is this study which I would like to report to you.

Consumer Acceptance of Four Varieties of Potatoes in the Portland Market

Four varieties of potatoes, two well known and two new varieties for the Portland market area, were used for the study. The established varieties were Katahdin and Green Mountain and the new varieties were Pontiac and Russet Burbank. All potatoes were washed, sized 2¼" to 3¼" with the exception of Russet Burbank which were sized four to 12 ounces. Each variety was packaged in 10-pound mesh window bags and distinctly identified by different colored printing and the variety name written on the bags. The color of the bags for Katahdin was orange, Green Mountain green, Pontiac red, and Russet Burbank blue.

The cooking qualities of the four varieties may be indicated in part by the total solid content (specific gravity) of the potatoes. The Green Mountain variety had the highest average specific gravity with 1.078, Katahdin variety was second, with 1.072; Russet Burbank third, with 1.068; and the Pontiac variety last, with 1.060. Thse specific gravity readings indicate that the Green Mountain would be relatively dry and flaky when cooked and the Pontiac with the lowest reading rather moist and less flaky.

In order to assure a constant supply of uniformly high quality potatoes to each of the cooperating stores, a distributing system was established. A supply of potatoes was placed in cold storage in Portland and distributed to the stores as needed to maintain a fresh uniform display of potatoes throughout the six-week period of the study.

Eight supermarkets in the Portland market area were chosen for the study. These supermarkets were selected to give a cross section of consumers in this market area. The study was conducted for a six-week period, February 1 to March 13, 1954. For the first five weeks of the six-week period, potatoes of each variety were priced at 39 cents per 10-pound bag. The last week the price was reduced to 35 cents per bag. Retail prices of unwashed U. S. No. 1 potatoes in these stores ranged from 29 to 39 cents per 15-pound bag and 65 to 99 cents for 50-pound bags. During the last two weeks of the study other washed potatoes in 5- and 10-pound polyethylene bags were placed on sale in the retail stores along with a campaign the last week to sell 50-pound bags of unwashed potatoes. This market situation probably increased total potato sales in the Portland market. But, with many kinds of potatoes for consumers to select their purchase, fewer potatoes were sold of each offering.

Consumers Prefer Qualities Found in Green Mountain Variety

Retail sales of the four varieties of potatoes in eight supermarkets in the Portland market area for the six-week's period amounted to 46,530 pounds or 4,653 ten-pound bags. Of this amount, 1,882 bags were Green Mountain; 1,409, Katahdin; 929, Russet Burbank; and 433, Pontiac. Expressed in percentages 40.4 per cent of the sales were Green Mountain; 30.3 per cent, Katahdin; 20.0 per cent, Russet Burbank; and 9.3 per

cent, Pontiac. This is in exact order of the average specific gravity of the four varieties.

Consumers' purchases in the Portland market area indicate a strong preference for the white skinned potato and one with a relatively high specific gravity. Consumers in this market are acquainted with the Green Mountain and the Katahdin varieties. The Russet Burbank is a relatively new variety in this area although it has been on the market in limited quantities during recent years. The Russet Burbank potatoes used in this study were slightly lower in specific gravity than the Katahdin variety. However, several lots of Russet Burbank grown in Maine in 1953 had a relatively high specific gravity. The Pontiac potatoes were relatively low in specific gravity, red in color and little known in the market. These two factors of the Pontiac variety may have helped to account for their unpopularity.

Consumers' Preferences Varied among Retail Stores

Consumers' acceptance of the four varieties of potatoes showed considerable variations among the eight supermarkets. The Russet Burbank and Pontiac varieties showed larger variations in sales between stores than the Green Mountain and Katahdin varieties. The Green Mountain variety had the highest percentage of sales for the six-week period of the four varieties in six of the eight stores. The Russet Burbank ranked first in two stores. Retail sales of the Pontiac variety were the lowest in all stores. The preference for the Katahdin variety was second in six of the eight stores.

Green Mountain Sales Increased over Six Week's Period

The retail sales of the four varieties of potatoes showed an increase the second week and then declined each week for the remaining four weeks of the study. The continuous decline may be attributed to the increased number of lots of potatoes and to various publicity programs during the last weeks of study. The last week of sales showed a drastic decline from the previous week although the retail price was changed from 39 to 35 cents per bag of 10 pounds. The price change is in contrast to the price decline for 50-pound bag of unwashed U. S. No. 1 potatoes from 89 to 65 cents in the northeast drive to sell more potatoes.

Retail sales of Green Mountain potatoes showed an irregular increase in the percentage of potatoes sold of the four varieties throughout the six-week period. Percentage-wise, weekly sales of the Katahdin variety were fairly well maintained but declined the last week. Pontiac sales declined each week increasing only in the sixth week. Sales of Russet Burbank showed a slight percentage decline each week with the exception of the third week.

Potato Sales Heaviest Last Three Days of Week

Retail sales of the four varieties during the first three days of the week amounted to 23.4 per cent whereas sales for the last three days of the week were 76.6 per cent. Saturday sales were slightly larger than those on Friday which were considerably higher than for Thursday. In addition to the practice of consumers shopping the last three days of the week, sales were influenced by pay periods.

POTATO SPECIFIC GRAVITY STUDIES[1]

M. P. RASMUSSEN

This report covers four years of a planned five to six-year potato research program.[2] The studies were undertaken because it was thought that a sizable proportion of the population (mostly in the medium and upper income groups) did not have ready access to potatoes suited to specific purposes and for which they were *able and willing to pay.*

The first trial study was initiated in two retail stores in Ithaca, New York, during the 1949-1950 season (1). Potatoes separated by specific gravity and sold in 5-pound bags made up one-fourth of the total potato sales in one of these stores and about one-eighth in the other store. This pilot plant study gave encouragement to the hypothesis that a reasonable proportion of consumers were in the market for potatoes separated as to specific uses and would pay premiums for them, that only two separations needed to be made ("Baking" and "Boiling"), that a 10-pound package or larger quantity should be offered for sale, and that there was a definite need for a commercial separator.

During the 1950-1951 season the study was abandoned because of the very low quality of all potatoes. During this period a specific gravity separator was constructed.[3] By the fall of 1951 a washing and drying machine and packing equipment had been set up on a large farm in central New York along with the commercial specific gravity separator.

During the 1951-1952 season two 6-week experiments were conducted in six large supermarket food stores of the Loblaw, Inc., chain in Syracuse, New York (2) (to ascertain consumer acceptance in a large industrial city). The experimental lots of potatoes were sorted into "Bakers" (with more than 1.080 specific gravity) and "Boilers" (with specific gravity of 1.080 or less). During two weeks of the first 6-week experiment 18 per cent of all potatoes sold were "Bakers," and 15 per cent were "Boilers." When a 5-cent premium (per 10-pound bag) was charged, sales of "Bakers" dropped to 15 per cent and "Boilers" remained at 15. When a 10-cent premium was charged, sales of "Bakers" dropped to 13 per cent and "Boilers" to 14. Unseparated potatoes of one kind or another accounted for two-thirds or more of total potato sales in these stores.

During the second 6-week experiment of the 1951-1952 study, an effort was made to determine what effect variations in number and kind of experimental lots would have on total sales. When each store had "Bakers", "Boilers" and unseparated "Purple Tag" potatoes on sale for two weeks, "Bakers" amounted to 16 per cent, and "Boilers", 15; and "Purple Tag" 14 per cent of the total sales. During a second two weeks

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[2]This project has been under the direction of Dr. M. P. Rasmussen, Dept. Agr. Econ., and of Dr. Ora Smith, Dept. Veg. Crops, Cornell Univ. Agr. Exp. Sta., Ithaca, N. Y. in cooperation with the Agr. Marketing Service, U. S. Dept. of Agr., Wash., D. C.
Brief resume of talk presented at the Sixth National Potato Utilization Conference, Ithaca, N. Y., Nov. 17, 1954.

[3]Through the cooperation of the Depts. of Vegetable Crops and Agricultural Engineering, at Cornell University (based on plans furnished by the Colo. Agr. Exp. Sta.).

when "Bakers" and "Boilers" were offered (but not the check lot of "Purple Tag" unseparated potatoes), "Bakers" amounted to 22 per cent and "Boilers" 23. During a third two weeks when neither "Bakers" nor "Boilers" were offered for sale, the unseparated "Purple Tag" check lots accounted for 37 per cent of the total potato sales.

It took just about twice as much labor to turn out a 10-pound bag of specific gravity potatoes as of the regular pack. It was estimated that costs for oil, electric power, salt, water, annual repairs, depreciation and interest on investment would approximate 16⅓ cents more per 100 pounds for handling specific gravity graded potatoes than for potatoes handled in the regular way, and that labor would cost 7.077 cents additional per 100 pounds—totaling about 3.5 cents per peck (assuming an annual production of 40,000 bushels).

During the 1952-1953 season the study was again continued in Syracuse. Of more than 144,000 pounds of potatoes sold in these six stores during the first 6-week study, "Baking" and "Boiling" potatoes each accounted for 15 per cent of total sales (3). When varying price premiums were charged for the specific gravity sorted potatoes, it was found that premiums varying from 5 to 10 cents per 15-pound bag could be charged and still maintain sales of such potatoes varying from 25 to 33 per cent of the total potato sales.

During the second 6-week period (January 19-February 28, 1953) premiums on experimental potatoes were held constant at 10 cents for "Baking", 6 cents for "Boiling" and 3 cents for unseparated "Blue Tag" potatoes. Of the 181,000 pounds of potatoes sold during this period, "Baking" potatoes accounted for 14 per cent; "Boiling", 15; and the unseparated "Blue Tag" potatoes 17 per cent. These data coincided to a remarkable degree with the proportion sold during the first 6-week period and would seem to indicate stability of demand on the part of nearly 30 per cent of the customers even at premiums of 10 cents for "Baking" and 6 cents for "Boiling". Costs of separating specific gravity potatoes during this period were estimated at approximately 2.9 cents per peck greater than for unseparated potatoes. Costs were reduced about ½-cent per peck by eliminating a heat drying element and relying on a double battery of rollers covered by rubber and woolen blankets to remove moisture from the washed potatoes.

The 1953 potato crop was considerably larger than the 1952 crop and prices averaged about 50 per cent less. It was, therefore, deemed wise by the chain management to reduce the retail premium on the specific gravity potatoes to 5 cents per peck on both "Baking" and "Boiling" lots, in comparison with regular New York potatoes. During this season the average specific gravity of potatoes was relatively low. In order to overcome this difficulty as well as to meet certain mechanical defects in the separator, the level of the solution was set at 1.077 to obtain the required ratio of "Baking" and "Boiling" potatoes. Furthermore, double-walled peck paper bags, with an open mesh window about 9" x 3½", were used in contrast with closed white multi-wall bags used during the two previous seasons. The most striking difference was the attempt to find out how advertising might effect potato sales. During the first 6-week experiment of the 1953-1954 season which was conducted in the Loblaw, Inc., chain in Syracuse, New York, "Baking" potatoes averaged 18 per

cent and "Boiling" potatoes 17 per cent of the total sales[4]. During the 3-week period (November 30-December 19, 1953) when a relatively modest program of advertising potatoes was followed, sales of "Baking" and "Boiling" potatoes were approximately 26 per cent greater than when such potatoes were not advertised, and the same was true for all potato sales.

The second 6-week study during the 1953-1954 season was conducted in seven stores of the Cooperative P & C Family Foods, Inc., in Syracuse, New York. These stores sold about 155,000 pounds of potatoes and of this total about 14 pounds of each 100 sold were "Baking", and the same was true of "Boiling" potatoes. During this second study it was intended that advertising would not be used during the first three weeks, but the unplanned and inadvertent use of a 10-cent free coupon made it necessary to tabulate the data in a different manner than had been intended. However, this offered a striking illustration of what a special sale or a sharp reduction in price could do in the way of increasing potato sales. During the week when the 10-cent free coupon was available, sales of all potatoes in these stores increased 55 per cent. Sales of "Baking" potatoes increased 35 per cent and "Boiling" potatoes 78. During the second three weeks when these experimental lots of potatoes were advertised in the local papers, sales of "Boiling" potatoes were about one-fourth more than during the first two weeks when the potatoes were not advertised, and "Baking" potatoes only increased about 3 per cent. The sales of all potatoes increased 15 per cent.

These data on the results of advertising need to be taken with some degree of reserve. They do not answer the question as to whether total potato consumption increased throughout the city. It does suggest that if a storekeeper wants to increase potato sales, advertising may help.

These studies have demonstrated that from 25 to 30 per cent of the customers in these stores were willing and able to pay for potatoes sorted according to use. The potato industry has probably been derelict in getting across to the housewife what potatoes are good for and how cheap a food they really are. If farm population continues to shrink, the job will be bigger than ever. An important problem is to interest those growers or shippers who have a large enough business to pick up this specific gravity idea and test and promote it energetically for several marketing seasons. It is believed this would assist in stabilizing the demand for potatoes and increasing the demand of those of our population in probably the upper one-third income bracket who have had difficulty in finding the kind of potatoes they desire.

[4]Unpublished report.

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LUCK OR LOGIC?

FRANCIS P. PUSATERI[1]

The freeze of March 26-27 in the southeastern portion of the United States affected some 45,000 acres of potatoes in Alabama, South Carolina, Mississippi, Louisiana, Texas, Oklahoma and Arkansas. It has been reliably established that approximately 10,000 carload equivalents were wiped out by this abnormal March freeze. Some sources even reported that for all practical purposes the entire Alabama potato crop (where 27,800 acres were planted) was a total loss. Many seasoned observers, however, report more conservatively that one-third of Alabama's planted acreage will be abandoned and that yields from the remaining 18,500 acres will be extremely low and will consist chiefly of creamers and Bees.

The accompanying tabulation gives a quick picture and comparison of the total commercial Irish potato early acreage, USDA suggested acreage goals, yields and production for the 1955 Early States. Disappearance at the rate of 28 million bushels per month during the recent months of January and February, based on USDA reports, would indicate a need for approximately 168 million bushels through the month of June — 118 million bushels from the reported merchantable stocks on hand, January 1, and the balance of 50 million from the early states. According to the tabulation presented here, it is indicated that 44,863,000 bushels will be produced by the early states.

As shown in the tabulation also, California has planted 70,000 acres this spring, or 23% more than the 57,000 acres suggested by the USDA last November. The 57,000 acres suggested was the figure USDA felt would be most apt to insure a stable potato economy this spring. Of the 1955 California late spring total (70,000 acres), Kern County planted 47,000, or 20% more than the USDA recommended. Despite the fact that California has planted in excess of what the government analysts felt would maintain the soundest potato economy in our area, it is indicated at this time that Kern County producers will enjoy a rather high level of return for their product.

Certainly it is obvious that the disaster in the southeastern potato states in March is having a very direct bearing on our potato economy — for the better. This turn of events cannot be attributed to our area's determination to hold acreage in line with consumption, which would maintain fair and reasonable returns, but is very directly due to an "act of God." To be very practical, our good fortune has been achieved through catastrophe of a competing area, and not through methods predicated on total "LOGICAL" planting. Modern day operations in production, marketing, construction, and other commercial endeavors of our country's economy, prove over and over that these processes must submit to logical economic planning or suffer bankruptcy. So it is with the producers of potatoes — where the demand for the product is quite inelastic and the slightest increase or decrease in production can cause relatively low or high prices. Our area actually overplanted, but due to a weather disaster, the delicate balance of potato supply and demand has fallen in our favor.

Based on the USDA rule of thumb which states that a 1% change in potato production from average will cause approximately a 3½% to

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4% change in price in the opposite direction, when other factors affecting prices remain constant, we can naturally conclude that NET RETURNS to the California early spring potato producer, had he planted as the USDA suggested last November, would have proven to have been even higher, percentagewise, than the proportionately higher acreage planted. But regardless of subsequent weather events, adhering to USDA suggested plantings would have protected the Kern producer's economic position even if Alabama had suffered no disastrous freeze. Thus, due to the misfortune of another area, our economy would have realized higher returns if it had followed USDA recommendations.

Following these potato acreage guides every year is a logical method of insuring the best level of returns. Under normal circumstances of overplanting, in the absence of weather disasters elsewhere, the price level result might well have been a disaster in OUR area this spring.

Should we plant potatoes on the basis of LUCK or LOGIC?

Crop and State	Acreage			Yield Per Acre		Production	
Early Commrcial Irish Potatoes	1954 acres	1955 sugg. goals	1955 ind. acres	1954 bus.	1955 ind. bus.	1954 bus. (1000 bus.)	1955 ind. bus.
Winter (total)	12,200	10,950	12,900	293	267	2571	3438
Early Spring							
Florida	20,800	20,200	25,000	295	246	6144	6100
Hastings	17,000		21,000	310	260	5270	5460
Other	3,800		4,000	230	170	874	640
Texas	2,200	2,200	250	80	80	176	20
Early Spring (total)	23,000	22,400	25,250	275	244	6320	6120
Late Spring							
California	57,000	57,000	70,000‡	400	400*	22800	28000
Louisiana	5,500	5,500	4,600	100	45*	550	207
Mississippi	600	600	650	110	75*	66	49
Alabama	19,700	19,700	18,500†	180	50*	3546	840
Georgia	600	600	600	115	80*	69	48
So. Carolina	7,000	7,000	6,500	190	150*	1330	975
Arizona	4,000	4,000	4,000	365	350*	1460	1400
Texas	4,200	4,200	3,800	70	60*	294	228
Oklahoma	500	500	500	190	180*	95	90
Arkansas	1,500	1,400	1,300	95	75*	142	98
Tennessee	1,600	1,600	1,300	150	115*	240	150
No. Carolina	13,500	15,000	14,000	250	230*	3375	3220
Late Spring (total)	115,700	117,100	125,750	294	280*	33967	35305
GRAND TOT.	150,900	150,450	163,900			43858	44863

*Unofficial.
†Total figure has had the abandoned acreage removed.
‡Broken down by county as follows: Kern—47,000; Tulare—6,800; Fresno, Kings, Madera—4,900; Riverside, San Bernardino—11,200; other areas—100.

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